AMENDMENTS TO THE CLAIMS

Claim 1 (Currently Amended): A nonaqueous electrolyte, comprising:

a nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinylethylene carbonate as a third solvent, the EC content falling within a range of 20 to 50% by volume based on the total amount of the EC and the BL, and the BL content falling within a range of 40 to 80% by volume based on the total amount of the EC and the BL; and

a solute dissolved in said nonaqueous solvent.

Claim 2 (Previously Presented): A nonaqueous electrolyte secondary battery, comprising:

a case having a wall thickness not larger than 0.3 mm;

a positive electrode provided in said case;

a negative electrode provided in said case; and

a nonaqueous electrolyte provided in said case and comprising a nonaqueous solvent and a solute dissolved in said nonaqueous solvent, the nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate, and vinylethylene carbonate, as a third solvent,

wherein, when a charge-discharge cycle test satisfying conditions (A) to (D) given below is performed under an environment of 45°C, the capacity retention rate at a 100-th charge-discharge cycle is at least 85% based on the discharge capacity in the first charge-discharge cycle:

(A) for the charging, the constant current-constant voltage charging to 4.2V is performed for 3 hours under a current of 1C;

(B) the discharging is performed to 3V under a current of 1C;

(C) after the charging, the secondary battery is left to stand for 10 minutes, followed by performing the discharging; and

(D) after the discharging, the secondary battery is left to stand for 10 minutes, followed by performing the charging.

Claim 3 (Original): The nonaqueous electrolyte secondary battery according to claim 2, wherein said EC is contained in an amount of 20 to 50% by volume based on the total amount of said EC and said BL, and said BL is contained in an amount of 40 to 80% by volume based on the total amount of said EC and said BL.

Claim 4 (Currently Amended): A nonaqueous electrolyte secondary battery, comprising:

a case having a wall thickness not larger than 0.3 mm;

a positive electrode provided in said case;

a negative electrode provided in said case; and

a nonaqueous electrolyte which is provided in said case and comprises a nonaqueous solvent and a solute dissolved in said nonaqueous solvent, said nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinylethylene carbonate as a third solvent, the EC content falling within a range of 20 to 50% by volume based on the total amount of the EC and the BL, and the BL content falling within a range of 40 to 80% by volume based on the total amount of the EC and the BL.

Claim 5 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said nonaqueous electrolyte is substantially in the form of a liquid or a gel.

Claim 6 (Previously Presented): The nonaqueous electrolyte secondary battery according to claim 4, wherein said third solvent is contained in an amount of 5% by weight or less based on the total amount of said nonaqueous solvent.

Claim 7 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 4, wherein, when said third solvent is formed of at least one ~~solvent~~ selected from the group consisting of phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinylethylene carbonate, the mixing amount of said third solvent is not larger than 3% by weight based on the total amount of said nonaqueous solvent.

Claim 8 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 4, wherein, when said third solvent is formed of ~~at least one solvent selected from the group consisting of 2-methylfuran, furan, thiophene, and~~ catechol carbonate, the mixing amount of said third solvent is not larger than 1.5% by weight based on the total amount of said nonaqueous solvent.

Claim 9 (Previously Presented): The nonaqueous electrolyte secondary battery according to claim 4, wherein, when ethylene sulfite is used as said third solvent, the mixing amount of said third solvent is not larger than 2% by weight based on the total amount of said nonaqueous solvent.

Claim 10 (Previously Presented): The nonaqueous electrolyte secondary battery according to claim 4, wherein said third solvent is formed of at least one solvent selected from the group consisting of ethylene sulfite, phenylethylene carbonate, catechol carbonate and vinylethylene carbonate.

Claim 11 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said solute includes at least one lithium salt selected from the group consisting of $LiC1O_4$, $LiPF_6$, $LiBF_4$, $LiAsF_6$, $LiCF_3SO_3$, $LiN(CF_3SO_2)_2$ and $LiN(C_2F_5SO_2)_2$.

Claim 12 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said negative electrode contains a carbonaceous material capable of absorbing-desorbing lithium ions.

Claim 13 (Original): The nonaqueous electrolyte secondary battery according to claim 12, wherein said carbonaceous material includes mesophase pitch based carbon fiber.

Claim 14 (Original): The nonaqueous electrolyte secondary battery according to claim 4, wherein said case is formed essentially of a metal plate, a metal film or a sheet including a resin layer.

Claim 15 (Currently Amended): A nonaqueous electrolyte secondary battery, comprising:

a case having a wall thickness not larger than 0.3 mm;

a positive electrode provided in said case;

a negative electrode provided in said case; and

a nonaqueous electrolyte layer which is arranged between said positive electrode and said negative electrode and comprises a nonaqueous electrolyte and a polymer for gelling said nonaqueous electrolyte, said nonaqueous electrolyte comprising a nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinylethylene carbonate as a third solvent, the EC content falling within a range of 20 to 50% by volume based on the total amount of the EC and the BL, and the BL content falling within a range of 40 to 80% by volume based on the total amount of the EC and the BL.

Claim 16 (Original): The nonaqueous electrolyte secondary battery according to claim 15, wherein the mixing amount of said third solvent is not larger than 5% by weight based on the total amount of said nonaqueous solvent.

Claim 17 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 15, wherein, when said third solvent is formed of at least one solvent selected from the group consisting of phenylethylene carbonate, ~~2-methylfuran, furan, thiophene,~~ catechol carbonate and vinylethylene carbonate, the mixing amount of said third solvent is not larger than 3% by weight based on the total amount of said nonaqueous solvent.

Claim 18 (Currently Amended): The nonaqueous electrolyte secondary battery according to claim 15, wherein, when said third solvent is ~~formed of at least one solvent selected from the group consisting of 2-methylfuran, furan, thiophene, and~~ catechol carbonate, the mixing amount of said third solvent is not larger than 1.5% by weight based on the total amount of said nonaqueous solvent.

Claim 19 (Previously Presented): The nonaqueous electrolyte secondary battery according to claim 15, wherein, when ethylene sulfite is used as said third solvent, the mixing amount of said third solvent is not larger than 2% by weight based on the total amount of said nonaqueous solvent.

Claim 20 (Previously Presented): The nonaqueous electrolyte secondary battery according to claim 15, wherein said third solvent is formed of at least one solvent selected from the group consisting of ethylene sulfite, catechol carbonate, vinylethylene carbonate and phenylethylene carbonate.

Claim 21 (Previously Presented): The nonaqueous secondary battery according to claim 4, wherein the content of said third solvent in the nonaqueous solvent falls within the range of 0.01% by weight to 5% by weight.

Claim 22 (Canceled)

Claim 23 (Previously Presented): The nonaqueous electrolyte according to claim 1, wherein the content of said third solvent in the nonaqueous solvent is not more than 5% by weight.

Claim 24 (Previously Presented): The nonaqueous electrolyte according to claim 1, wherein the content of said third solvent in the nonaqueous solvent falls within the range of 0.01% by weight to 5% by weight.

SUPPORT FOR THE AMENDMENT

This Amendment cancels Claim 22; and amends Claims 1, 4, 7-8, 15 and 17-18. Support for the amendments is found in the specification and claims as originally filed. In particular, support for Claims 1, 4 and 15 is found at least in canceled Claim 22. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1-21 and 23-24 will be pending in this application. Claims 1, 2, 4 and 15 are independent.

REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

The present invention provides a non-aqueous electrolyte, and a secondary battery including the non-aqueous electrolyte. The non-aqueous electrolyte comprises a non-aqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate, and vinylethylene carbonate as a third solvent. The third solvent makes it possible to form a dense protective film on the surface of the negative electrode of the secondary battery. As a result, the reaction between the negative electrode and the γ- butyrolactone in a high temperature environment can be suppressed. This improves the charge-discharge cycle life of the secondary battery in the high temperature environment. See, specification at page 41, lines 10-23.

Claims 1 and 23-24 are rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 5,993,997 ("Fujimoto") in view of EP 0 759 641 ("Mao"). In addition, Claims 2-14, 21 and 23 are rejected under 35 U.S.C. § 103(a) over Fujimoto and Mao and further in view of U.S.

Patent No. 6,048,639 ("Sonozaki"). Claims 15-20 are rejected under 35 U.S.C. § 103(a) over U.S. Patent No. 6,465,134 ("Shibuya") in view of Mao and Sonozaki.

Fujimoto discloses lithium secondary batteries comprising a non-aqueous solvent consisting of ethylene carbonate (EC) and γ-butyrolactone (BL). Fujimoto at column 21, Example 18. However, the Final Rejection, via the Office Action dated June 26, 2003, admits that Fujimoto does not suggest the addition of any of the recited third solvents. Office Action dated June 26, 2003, at page 2, lines 22-23.

Shibuya discloses lithium batteries comprising a gel electrolyte containing ethylene carbonate (EC), propylene carbonate (PC) and γ-butyrolactone (BL). Shibuya at column 5, 16-18. However, the Final Rejection, via the Office Action dated June 26, 2003, admits that Shibuya does not suggest the addition of any of the recited third solvents. Office Action dated June 26, 2003, at page 4, lines 9-10.

Sonozaki is cited for disclosing battery casings with walls less than 0.3 mm thick.

Mao discloses non-aqueous rechargeable lithium batteries can be protected against overcharge abuse by incorporating small amounts of suitable aromatic additives into the electrolytes of the batteries. Mao at abstract. Mao discloses that examples of aromatic heterocyclic compounds are furan, thiophene, and derivatives thereof. Mao at page 4, lines 48-49.

However, Mao and the other cited prior art fail to suggest the limitation of independent Claims 1, 4 and 15 of a nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and "at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, catechol carbonate and vinylethylene carbonate" as a third solvent. Thus, the prior art rejections of independent Claims 1, 4 and 15 should be withdrawn.

The cited prior art also fail to suggest the independent Claim 2 limitation of a "nonaqueous solvent containing ethylene carbonate (EC), γ-butyrolactone (BL), and at least one selected from the group consisting of ethylene sulfite, phenylethylene carbonate, 2-methylfuran, furan, thiophene, catechol carbonate, and vinylethylene carbonate, as a third solvent, wherein, when a charge-discharge cycle test satisfying conditions (A) to (D) given below is performed under an environment of 45°C, the capacity retention rate at a 100-th charge-discharge cycle is **at least 85%** based on the discharge capacity in the first charge-discharge cycle".

As discussed above, the Final Rejection admits that the primary references, Fujimoto and Shibuya, do not suggest the addition of the recited third solvent. Thus, Fujimoto and Shibuya also fail to suggest the improvement in charge-discharge cycle life (capacity retention rate) that Applicants have found results from the addition of the recited third solvent to a nonaqueous electrolyte containing ethylene carbonate (EC) and γ-butyrolactone (BL).

Mao discloses in FIG. 3, reproduced below, the variation in secondary battery capacity with cycle number for secondary batteries containing solvent mixtures of ethylene carbonate (EC) and diethyl carbonate (DEC)(see, Mao at page 6, lines 45-47).

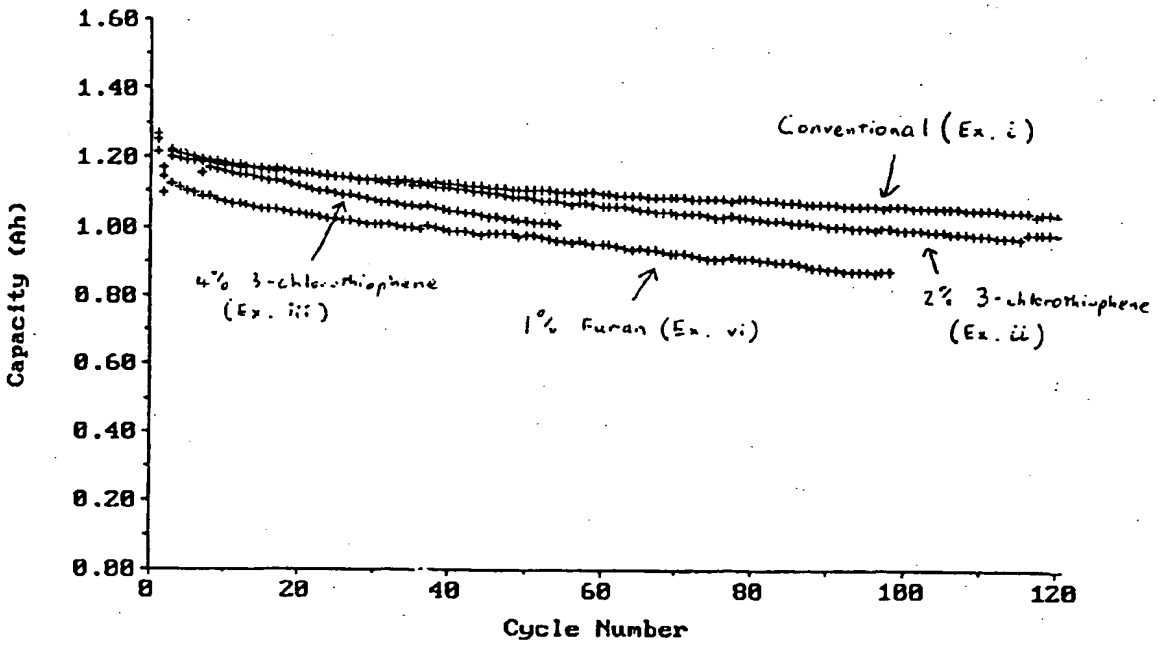


FIG. 3

Mao's FIG. 3 shows that the addition of a third solvent to ethylene carbonate (EC) and diethyl carbonate (DEC) ***degrades*** capacity retention relative to conventional batteries containing solvent mixtures of only ethylene carbonate (EC) and diethyl carbonate (DEC)

However, Mao is silent about the capacity retention effect of the recited third solvent in a nonaqueous electrolyte containing ethylene carbonate (EC) and γ-butyrolactone (BL).

In contrast to Mao, the specification shows at Tables 1-4, reproduced below, that the addition of the recited third solvent to ethylene carbonate (EC) and γ-butyrolactone (BL) ***improves*** capacity retention relative to secondary batteries containing only ethylene carbonate (EC) and γ-butyrolactone (BL). Table 4 shows that in Comparative Examples 3, 4, 6 and 8, which include ethylene carbonate (EC) and γ-butyrolactone (BL), but lack the recited third

solvent, the capacity retention rate is a maximum of 75%. In contrast, Tables 1-3 shows that Examples 1-25 of the present invention, which include ethylene carbonate (EC), γ-butyrolactone (BL) and the recited third solvent, exhibit improved capacity retention rates of 87 to 95%. The capacity retention rates (%) were obtained at the 100-th cycle and are relative to the 1-st cycle (corresponding to 100%) when the charge-discharge cycle is performed at 45°C. See, specification at page 48, line 27 to page 49, line 25.

Table 1

	Nonaqueous solvent	Solute	Solute concentration (mol/L)	Maximum discharge capacity (Ah)	Capacity retention rate (%)	Swelling (%)
Example 1	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% ES;	$LiBF_4$	1.5	0.52	95	1
Example 2	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% phEC;	$LiBF_4$	1.5	0.52	87	1
Example 3	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% 2Me-F;	$LiBF_4$	1.5	0.52	90	2
Example 4	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% F;	$LiBF_4$	1.5	0.52	88	2
Example 5	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% TIOP;	$LiBF_4$	1.5	0.52	93	2
Example 6	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% CATC;	$LiBF_4$	1.5	0.52	92	1
Example 7	mixed solvent of EC and BL (volume ratio 33:67) 99.5 wt%, 0.5 wt% VEC;	$LiBF_4$	1.5	0.52	95	1
Example 8	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% ES;	$LiBF_4$	1.5	0.50	90	1
Example 9	mixed solvent of EC and BL (volume ratio 33:67) 96 wt%, 4 wt% phEC;	$LiBF_4$	1.5	0.52	87	1
Example 10	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% 2Me-F;	$LiBF_4$	1.5	0.51	90	2

Table 2

	Nonaqueous solvent	Solute	Solute concentration (mol/L)	Maximum discharge capacity (Ah)	Capacity retention rate (%)	Swelling (%)
Example 11	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% F;	$LiBF_4$	1.5	0.50	88	2
Example 12	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% TIOP;	$LiBF_4$	1.5	0.50	93	2
Example 13	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% CATC;	$LiBF_4$	1.5	0.50	92	1
Example 14	mixed solvent of EC and BL (volume ratio 33:67) 98 wt%, 2 wt% VEC;	$LiBF_4$	1.5	0.52	93	1
Example 15	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% ES;	$LiBF_4$	1.5	0.43	87	2
Example 16	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% phEC;	$LiBF_4$	1.5	0.48	90	2
Example 17	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% 2Me-F;	$LiBF_4$	1.5	0.45	90	4
Example 18	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% F;	$LiBF_4$	1.5	0.43	88	4
Example 19	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% TIOP;	$LiBF_4$	1.5	0.43	90	4
Example 20	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% CATC;	$LiBF_4$	1.5	0.43	91	3
Example 21	mixed solvent of EC and BL (volume ratio 33:67) 93 wt%, 7 wt% VEC;	$LiBF_4$	1.5	0.48	87	2

Table 3

	Nonaqueous solvent	Solute	Solute concentration (mol/L)	Maximum discharge capacity (Ah)	Capacity retention rate (%)	Swelling (%)
Example 22	mixed solvent of EC and BL (volume ratio 40:60) 99.5 wt%, 0.5 wt% ES;	$LiBF_4$	1.5	0.52	93	1
Example 23	mixed solvent of EC and BL (volume ratio 25:75) 99.5 wt%, 0.5 wt% ES;	$LiBF_4$	1.5	0.52	92	1
Example 24	mixed solvent of EC and BL (volume ratio 40:60) 99.5 wt%, 0.5 wt% VEC;	$LiBF_4$	1.5	0.52	94	1
Example 25	mixed solvent of EC and BL (volume ratio 25:75) 99.5 wt%, 0.5 wt% VEC;	$LiBF_4$	1.5	0.52	93	1

Table 4

	Nonaqueous solvent	Solute	Solute concentration (mol/L)	Maximum discharge capacity (Ah)	Capacity retention rate (%)	Swelling (%)
Comparative Example 1	100vol.%BL	$LiBF_4$	1.5	0.30	10	1
Comparative Example 2	25 vol.%EC,50 vol.%BL,25 vol.%MEC	$LiBF_4$	1.5	0.30	20	100
Comparative Example 3	75 vol.%EC,25 vol.%BL	$LiBF_4$	1.5	0.40	30	20
Comparative Example 4	1 vol.%EC,99 vol.%BL	$LiBF_4$	1.5	0.35	10	10
Comparative Example 5	25 vol.%EC,75 vol.%MEC	$LiPF_6$	1.5	0.52	0.1	50
Comparative Example 6	33 vol.%EC,67 vol.%BL	$LiBF_4$	1.5	0.52	75	1
Comparative Example 7	40 vol.%EC,60 vol.%BL	$LiBF_4$	1.5	0.52	75	1
Comparative Example 8	25 vol.%EC,75 vol.%BL	$LiBF_4$	1.5	0.52	75	1
Comparative Example 9	33 vol.%EC,66 vol.%BL,1 vol.%VC	$LiBF_4$	1.5	0.52	79	2

Because the cited prior art fails to suggest the improvement in charge-discharge cycle life achieved according to the present invention by the combination with ethylene carbonate (EC) and γ-butyrolactone (BL) of the recited third solvent; and because conventional batteries, with ethylene carbonate (EC) and γ-butyrolactone (BL) but none of the recited third solvent, have capacity retention rates of 75% or less, the cited prior art fails to suggest the independent Claim 2 limitation that "the capacity retention rate at a 100-th charge-discharge cycle is at least 85%".

Furthermore, any *prima facie* case for the obviousness of independent Claim 2 based on the cited prior art is rebutted by the significant improvement in capacity retention rate achieved according to the invention of independent Claim 2 using the nonaqueous solvent containing ethylene carbonate (EC), γ- butyrolactone (BL) and at least one of the recited third solvents. The cited prior art fails to suggest the significant improvement in capacity retention rate from the conventional 75% to the 87-95%, as discussed above, that is achieved by the present invention by the inclusion of the recited third solvents in the nonaqueous solvent containing ethylene carbonate (EC) and γ- butyrolactone (BL).

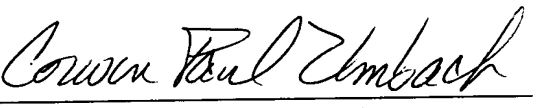
Because the cited prior art fails to suggest all the limitations of independent Claim 2, and any *prima facie* case for the obviousness of Claim 2 is rebutted, the rejection of independent Claim 2 under 35 U.S.C. § 103 should be withdrawn.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,
MAIER & NEUSTADT, P.C.



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